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NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 9-89

FULL FACE MASK FOR USE WITH MK 16 UBA

MMC(DV) GARRY ASHTON, USN

JULY 1989

NAVY EXPERIMENTAL DIVING UNIT

DEPARTMENT OF THE NAVY
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This study served to evaluate full face masks (FFM) for use with the MK 16 UBA. The five masks evaluated were separated into two groups based on capabilities of the masks. The first group included the British FFM, AGA Closed Circuit FFM and the Cressi-Sub FFM, all of which are non-developmental masks currently in use by various units world-wide. These masks simply provide facial protection (thermal and environmental) to the diver. The exception being the AGA FFM which can be modified to allow a divers communication system. The second group consisted of the AGA OC1 open/closed circuit switchover mask and the AGA FFM frame and rubber (continued)

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19. CONTINUED

skirt incorporating an open/closed switchover mechanism developed by NCSC, Panama City, Florida. Both of these masks afford not only the inherent protection of a FFM, but also the capability of diver-to-diver, diver-to-surface communications and a safer more reliable method of providing emergency breathing gas to the divers. The first group of masks were dove by NEDU personnel and EOD fleet operators to provide for a broad base of diver input. It was determined from these evaluations that the Cressi-Sub FFM provided the most comfortable, reliable, and efficient performance when used with the MK 16 UBA. The second group of masks were dove by NEDU personnel during MINI-SAT 89. The NCSC switchover mechanism was preferred by all diver-subjects due to location, number and ease of use of the switchover components. The Cressi-Sub FFM is recommended for immediate use as an alternative to the standard mouthpiece configuration with the MK 16 UBA where thermal or environmental protection is a requirement. It is also recommended that the EOD community provide input in the development of the NCSC switchover mechanism for incorporation with the MK 16 UBA and EBS systems.

GLOSSARY

ANU	authorized for Navy use
EBS	emergency breathing system
EOD	Explosive Ordnance Disposal
FFM	full face mask
FSW	feet of seawater
kPa	kilo pascals
NAVSEA	Naval Sea Systems Command
NCSC	Naval Coastal Systems Center
NEDU	Navy Experimental Diving Unit
QD	quick disconnect
UBA	underwater breathing apparatus

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I. INTRODUCTION

During deep diving evolutions, MK 16 divers incur extremely long in-water decompression obligations. Use of a full face mask (FFM) could provide both physical and psychological comfort to the diver, two-way communications to the surface and a switchover capability to the emergency breathing system. On no-decompression dives, a switchover capability is not necessary but full face protection may still be warranted (i.e. cold or contaminated water, jelly fish infested water, etc.). Also of concern is that during MK 1 MOD 0 dry suit studies in January 1988, several of the diver subjects could not achieve a water tight seal using the currently provided MK 16 neoprene rubber face mask due to the rigidity of that material in 40°F water. This led to accelerated use of diluent to de-water the mask which could compromise an extended in-water decompression schedule.

The Navy Experimental Diving Unit (NEDU) was tasked by Naval Sea Systems Command (NAVSEA) to evaluate the AGA OC1 switchover FFM (OC1) (Interspiro, Branford, CT) for use with the MK 16 underwater breathing apparatus (UBA) and MK 16 operational support equipment.[1]

Offgassing due to poor sealing qualities has been a major shortcoming in past evaluations of FFMs. In addition to the AGA OC1 evaluation, a study of several other FFMs designed for use with closed circuit UBAs was conducted during Mini-Sat 89, a 200 FSW HeO_2 saturation dive. Five FFMs were evaluated during this study utilizing EX 15 MOD 1 UBAs which have the same breathing loop components as a MK 16 UBA. The first two masks were the British Royal Navy FFM and the AGA FFM. The British mask has been in use by Royal Navy divers in excess of 20 years and the AGA closed-circuit FFM is currently in use by the U.S. Navy Special Warfare community with the MK 15 UBA. The next two masks, the AGA open/closed circuit (OC1) and NCSC Switchover Mask, while using the same frames and rubber seals as the AGA FFM, incorporate an open/closed circuit switchover mechanism. This switchover capability when used with the Explosive Ordnance Disposal (EOD) Emergency Breathing System (EBS) would provide a safer and more reliable alternative to the open circuit second stage regulator currently in use, and also provide for two-way communication between divers and the surface during decompression. The OC1 is approved for use with the MK 15/16[2].

Also evaluated through this study was the Cressi-Sub FFM (Cressi-Sub, USA, Inc., Gloster, NJ). This mask was originally designed for use with open circuit SCUBA but is compatible with the MK 16.

II. OBJECTIVE

The objectives of this study were two-fold. First, an evaluation was conducted of FFMs currently used with closed circuit UBAs, or compatible with the MK 16 UBA, for immediate use by the EOD community. Second, a human factors comparison of the switchover mechanisms of the OC1, identified for potential use with the MK 16[2], and the switchover mechanism of the FFM currently being developed by Naval Coastal Systems Center (NCSC), Panama City, Florida, for use with the MK 15/16 and EX 19.

III. FUNCTIONAL DESCRIPTION OF EQUIPMENT

A. BRITISH FFM (Figure 1)

This mask is used with appropriate mouthpiece fittings in conjunction with various types of breathing apparatus by Royal Navy mine clearance divers. The mask is made of rubber and has a wide vision perspex visor riveted and sealed into the front of the mask. The mask is held against the face by a rubber spider having six straps, each reeved through a clip on the edge of the mask, each clip having a release tab. A rubber sleeve in the front of the mask accepts the mouthpiece assembly, which is then bound to the sleeve.

The mask seals to the diver's face by means of a water seal comprising a thin rubber duct bonded around the inside of the mask and completely filled with distilled water. The water filling makes a pliable seal which, when subjected to external water pressure, adapts to the shape of the diver's face. A padded spring clip is placed on the diver's nose to allow for equalization of pressure in the eustachian tubes and middle ear during descent. This mask is available in both a standard and a nonmagnetic version.

B. AGA CLOSED-CIRCUIT FFM (Figure 2)

The AGA FFM is designed to perform the following functions:

1. Form a watertight envelope over the entire face with a wide-angle faceplate for vision.

2. Provide a manifold with inlet and outlet non-return valves, a shutoff valve, and an inner oral-nasal mask to control the flow of breathing gasses to and from the diver.

3. Provide a nose-clearing device for equalizing pressure in the middle ear during descent.

4. Contain a microphone for diver communications.

A five-strap head harness holds the mask in position on the face. Inhalation and exhalation hoses connect the mask's manifold assembly to the breathing apparatus. Upon inhalation, gas flows through a non-return (uni-directional) valve (right side) at the manifold inlet and then through a shutoff valve into the oral-nasal cavity where the diver inhales it. Exhaled breath passes back through the shutoff valve and exhaust non-return valve (left side) into the breathing apparatus via the exhalation hose. The diver may press against the bottom of the mask which causes the nose-clearing device to seal the nostrils and permits him to equalize pressure of the eustachian tubes and middle ear during descent. Plugging a communications cable into the mask's microphone connector permits voice communications while submerged. Closing the shutoff valve permits removal of the mask in the water without flooding the underwater breathing apparatus. For this study a low volume visor was used with the AGA FFM.

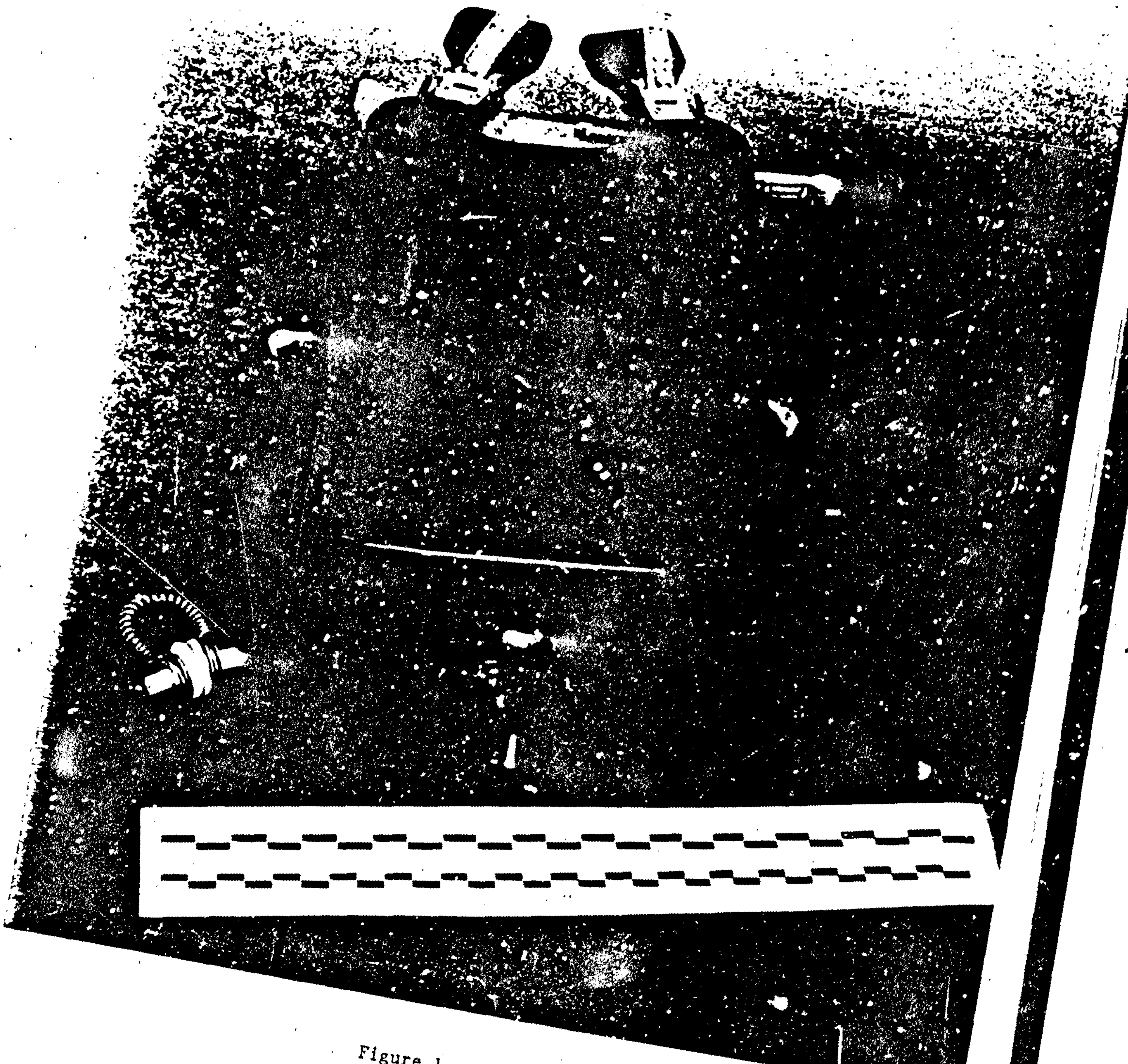

Figure 1. British EFM

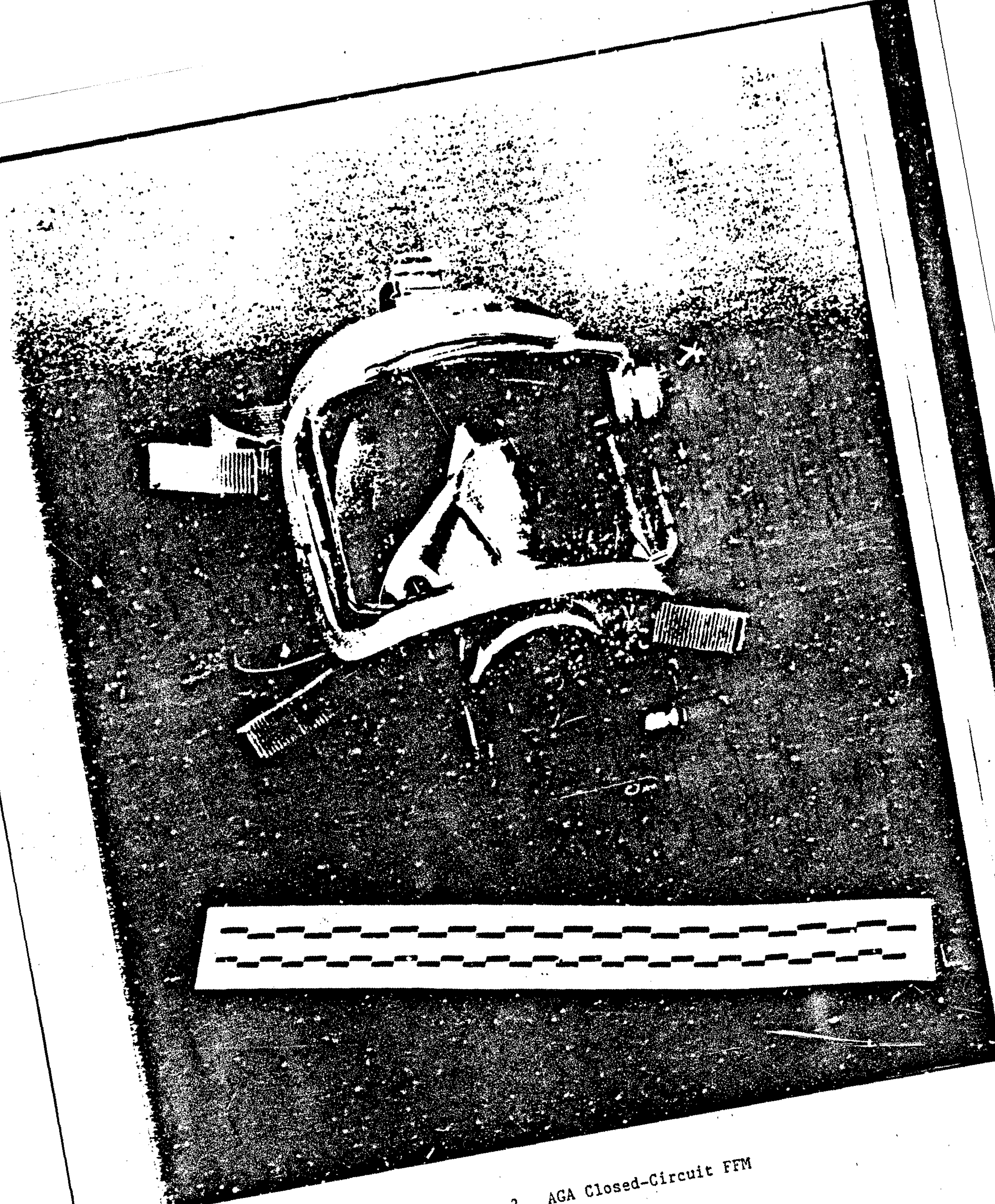

Figure 2. AGA Closed-Circuit FFM

C. CRESSI-SUB FFM (Figure 3)

The Cressi-Sub FFM (part #HA750089) has a design based on a standard dive mask, with an extended rubber skirt which extends and seals below the chin. A preformed opening in the skirt is designed to accept various mouthpieces. For the purpose of this study a standard MK 16 mouthpiece was used. The mouthpiece assembly is bound through the molded sleeve on the mask forming a watertight seal. This mask uses a three-legged spider to hold its position on the diver's face. This mask is currently being produced as a nonmagnetic version which is to be incorporated on the Siva closed-circuit UBA which will be used by Canadian and British EOD communities.

D. AGA OC1 FFM (Figure 4)

The AGA OC1 FFM with open circuit/closed circuit switchover capability (Figure 4) provides the same basic AGA mask body as the current AGA closed-circuit FFM. A modified manifold provides both open circuit and closed circuit functioning. The closed circuit portion of the manifold and modifications to the open circuit exhaust and open circuit low pressure flex hose provide a means of switching breathing modes during the dive.

1. FFM and Open Circuit Second Stage Regulator. Open circuit breathing gas is supplied to the AGA Divator II second stage regulator at 110-150 psi ambient. The regulator is fitted with a double diaphragm safety pressure device which consists of a spring loaded assembly and second diaphragm. This creates a positive pressure to the mask of approximately 2 cm of water (0.20 kPa) and is intended to prevent mask flooding (prevents water ingress) and provides increased mask comfort and improved breathing performance.

When open circuit gas is provided to the regulator the positive pressure feature is activated by the diver taking his first breath or by activating the positive pressure switch. The mask is held in place by an adjustable spider band. A seal is achieved by the positive pressure acting on a reversed lip around and inside the skirt of the mask. This feature is designed to ensure a comfortable fit and seal without the need to cinch down hard on the spider band during open circuit functioning.

During inhalation, the gas flows from the second stage through two demister ports, across the faceplate and into the oral-nasal through two mushroom valves.

During exhalation, gas is expelled to the ambient water through the exhalation valve. Inhalation and exhalation gasses pass through separate channels in the second stage to avoid mixing.

The exhalation valve is specially modified with a lever to secure FFM exhaust when diving in the closed circuit mode. In the open circuit mode the lever extends outward, perpendicular to the exhaust valve cover. In the closed circuit mode the lever must be hand secured shut by pressing the lever flush against the exhaust valve cover. This lever is designed to snap shut,

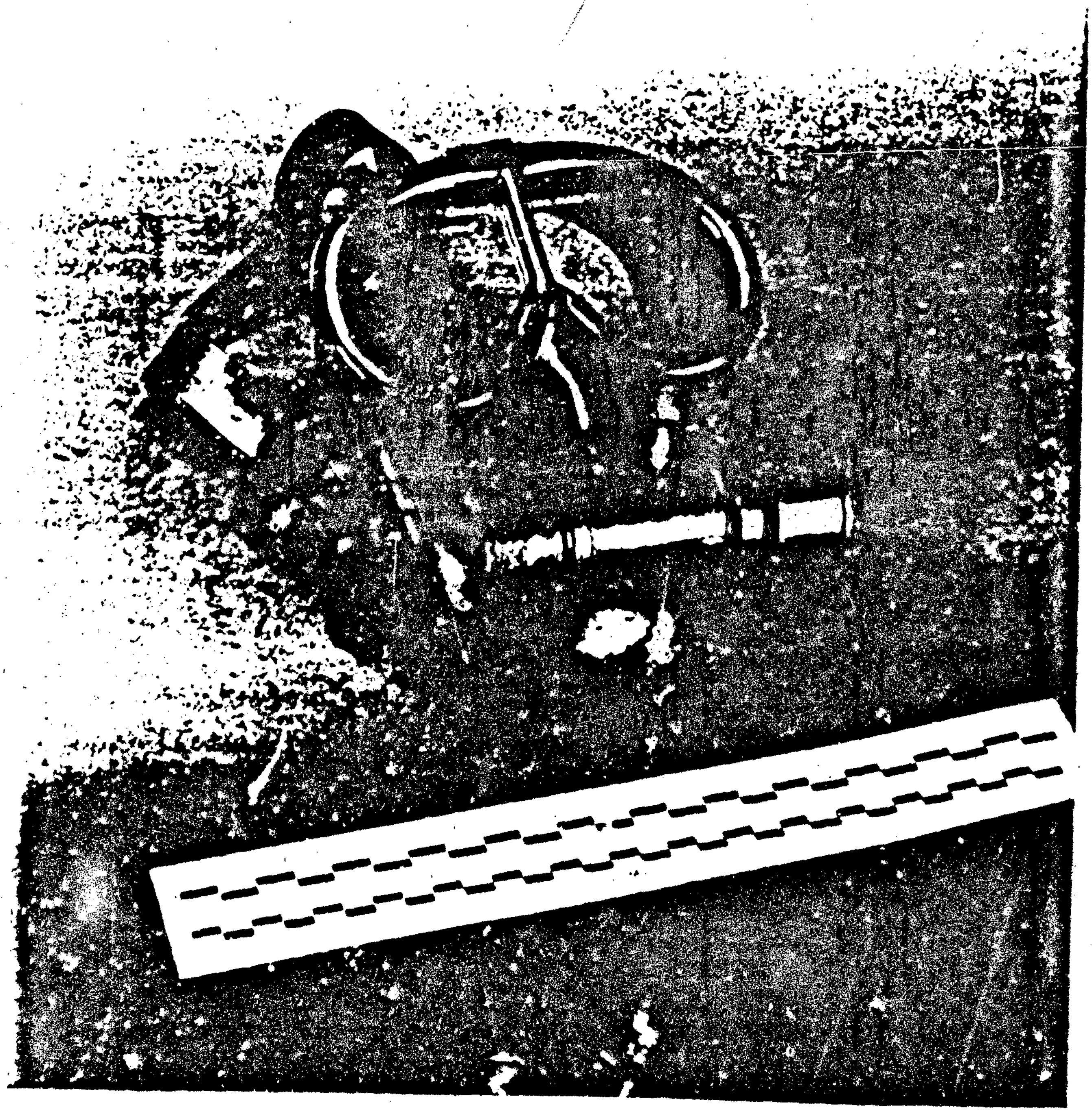

Figure 3. Cressi-Sub FFM

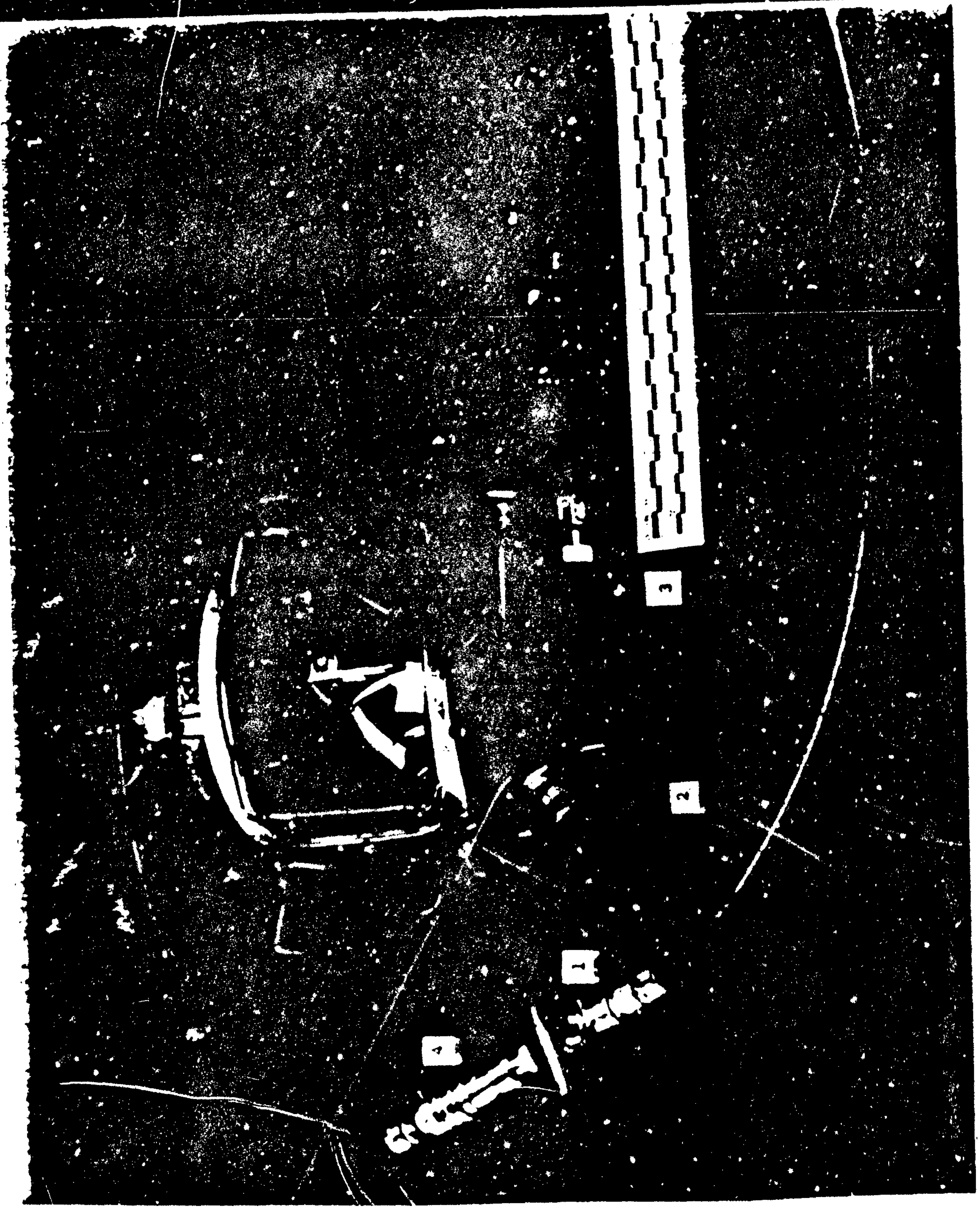

Figure 4. AGA OCI FFM

and is located where the purge valve is normally located. A purge valve is not provided in this configuration, and is not considered essential when the positive pressure regulator configuration is used.

2. Gas Supply. A 38 inch LP hose (I.D. 7.4 ± .4mm) was provided with the OC1 for open circuit air supply. This whip is joined to an umbilical (EBS) with a quick disconnect (QD) fitting, attached to a ¼ turn Whitey ball valve (attached upstream of QD) to open or secure the open circuit air source.

The QD fitting has a non-return valve to prevent gas escaping when released. This fitting allows the diver to connect to an open circuit supply, as required, during decompression.

Closed circuit hose fittings are designed for the MK 16 UBA size hoses.

3. Communications. The OC1 manifold requires exclusion of the detachable cover plate found on the standard AGA FFM. This cover plate is normally used to provide communications fitting access to the oral-nasal, and can be drilled and fitted with a suitable penetrator, microphone, and connector.

Absence of a cover plate on the OC1 requires that the manifold be specially drilled for installation of a penetrator and connector. The microphone is then attached to the bottom of the nose clearing device. Microphone, penetrator, and connector installation was engineered by Ocean Technology Systems (OTS) (Santa Ana, CA). A Crouse-Hinds Jay Molded Products 51F2F-10 (LaGrange, NC) female connector was installed on the mask for evaluation. This connector provides approximately 6 inches of wire length, enabling the diver to bring the female fitting within his field of vision when mating the male and female ends.

4. FFM Functioning. To place the mask in the closed circuit mode, the three valves must be aligned as follows:

a. Secure ¼ turn air supply valve (1) if so equipped.

b. Secure open circuit exhaust valve (snap shut) (2).

c. Rotate plunger valve assembly (3), opening the closed circuit breathing loop.

Switching to open circuit function requires that three valves be properly aligned (Figure 4).

a. Ensure the QD is attached (4).

b. Rotate the plunger valve to the secured position (3), sealing off the closed circuit breathing loop.

c. Pull out the open circuit exhaust valve securing lever (2).

d. Open the ¼ turn air supply valve (1).

Improper valve sequence when switching breathing modes can be quickly corrected. The most important consideration in proper valve sequence is ensuring the open circuit exhaust valve is open prior to opening the air supply, otherwise a rapid free flow of air will occur in the mask.

E. NCSC SWITCHOVER FFM (Figure 5)

The NCSC switchover is a single maneuver device which allows a diver to change from breathing on a closed circuit UBA to breathing on a standard open circuit SCUBA regulator manufactured by ScubaPro Inc., Rancho Domingo, CA. As shown, the switchover is designed to fit into the muzzle of a standard AGA FFM replacing the muzzle plate and AGA regulator. The AGA mask is Authorized for Navy Use (ANU).

The switchover consists of two parts: the closed circuit portion with check valves and the open circuit portion with plug valve and second stage regulator.

The closed circuit portion functions by opening a flow path to the diver and to the inhalation/exhalation hoses simultaneously while isolating the second stage regulator and open circuit exhaust valve.

The open circuit part of the switchover supplies gas to the second stage regulator when the single maneuver lever attached to the plug valve (1) is rotated 90° changing from closed circuit to open circuit. This single action isolates the diver from the closed circuit UBA while connecting him to the second stage regulator and to the exhaust valve located at the bottom of the switchover.

The entire assembly is being constructed from nonmagnetic material to meet EOD specifications and will incorporate a drinking tube and communications in the next prototype.

IV. PROCEDURES

Four of the five masks were evaluated during Mini-Sat 89 at 26 FSW and 39 FSW. The Cressi-Sub mask was not dove during the Mini-Sat because it was not initially designed as a closed-circuit mask. But, due to the strong preference for this mask under NAVSEA Task 88-58 (evaluation of SCUBA Full Face Masks)[3] and it is in fact compatible with the MK 16 UBA it was later incorporated into this study. Dives during the Mini-Sat were conducted using the following procedures and were documented by video recording.

1. The diver assumed positions of upright, prone, head-down, and supine. The amount of offgassing from the masks was reported by the diver for each position (0 indicating no offgasing, 1 for slight offgasing, and 2 for excessive offgasing) as well as documented by video recording. Also, a grade was given for the divers relating comfort in each position (0 indicating no discomfort, 1 being slightly uncomfortable, and 2 for an extremely uncomfortable position).

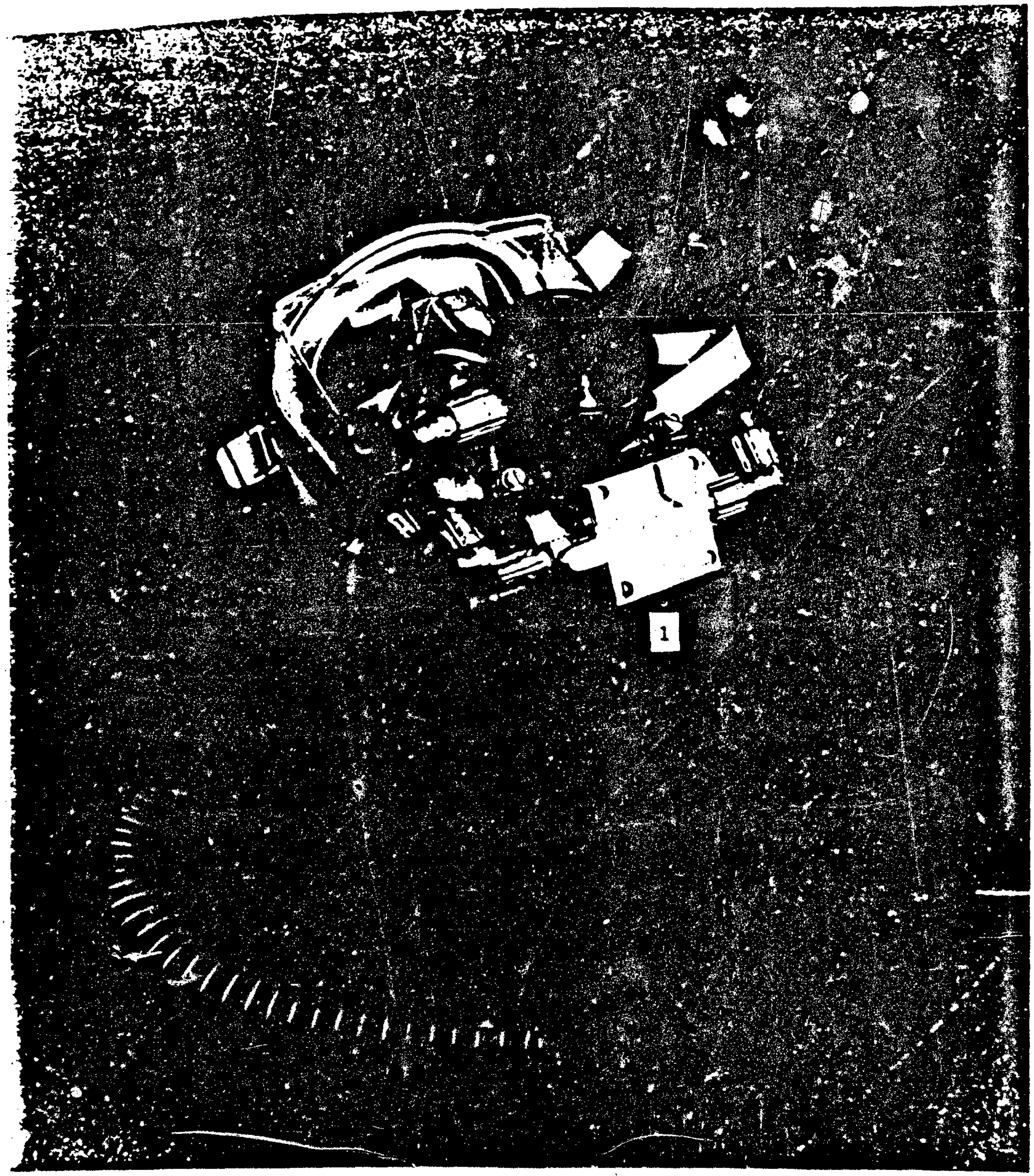

Figure 5. NCSC Switchover FFM

2. The diver assumed a prone position on a bicycle ergometer (Collins Pedalmate, Braintree, MA). He was then required to pedal at 50 watts for 5 minutes to simulate a light to moderate workload. At the end of 5 minutes a grade was given by the diver for offgassing experienced and relative comfort of the mask.

3. The ergometer was then placed in a vertical orientation so as to situate the diver in a head-up position to simulate decompression stops. He then was required to pedal at 50 watts for an additional 5 minutes. On completion of this work cycle a grade for offgassing and comfort was again given.

4. This concluded the tests for the British FFM and the AGA FFM. For the OCl and NCSC switchover masks further tests were performed.

5. On completion of the ergometer work cycles the diver then moved to an umbilical suspended in the water. He was required to connect the gas umbilical to the whip on the mask. For the OCl he was also required to connect a communications umbilical. This was done to simulate connections that will be required at an EBS umbilical.

6. The diver was then required to switch from breathing of the closed circuit UBA to breathing in open circuit from the umbilical. He then switched back to closed circuit and disconnected from the umbilical. A grade was given for the ease of accomplishing both the connection of the umbilical and the actions required to switch from breathing off the UBA to breathing off the umbilical (0 indicating no problems in performing these tasks, 1 meaning the tasks were slightly difficult, and 2 meaning the tasks were very difficult).

7. An additional evaluation was conducted under NEDU Test Plan 89-11 to provide a direct comparison between the British FFM and the Cressi-Sub mask, preferred by most divers during testing for NAVSEA Task 88-58 (Evaluation of SCUBA Full Face Masks)[3]. To effectively evaluate these two masks, which both met the NEDU criteria recommending approval, fleet operators assisted in the final evaluation. The goal was to determine which mask EOD personnel felt best suited their needs while performing an actual EOD scenario (i.e. sonar search). The masks were dove in the Charleston, South Carolina operating area in water at 50°F and varying depth from 43 to 52 feet, using the following procedure:

a. Two divers, each with a MK 16 UBA with a candidate mask, entered the water.

b. After surface checks, both divers descended to 10 FSW to "get comfortable" with the masks.

c. Divers then returned to the surface to verify with the diving supervisor their readiness to continue the evaluation.

d. Divers then descended on the anchor line to the bottom and conducted various simulated EOD tasks with a maximum bottom time of 30 minutes.

e. Divers returned to the surface and switched rigs and masks.

f. Divers then accomplished steps a. through e. with the second mask.

g. Upon completion of dive 2 both divers were questioned concerning the FFMs and a questionnaire was completed for each mask.

V. RESULTS

The following tables outline the data gathered in these studies. The numbers inside the graphs are the total number of divers scoring the mask at that level.

A. OFFGASSING EVALUATION (MINI-SAT 89)

Table 1
British FFM Offgassing

Position	Diver Assessment		
	None	Slight	Excessive
Vertical (Ergometer)	14	1	0
Prone (Ergometer)	15	0	0
Supine	10	5	0
Prone	13	2	0
Head-Down	13	2	0
Upright	15	0	0

Table 2
AGA Closed-Circuit FFM Offgassing

Position	Diver Assessment		
	None	Slight	Excessive
Vertical (Ergometer)	6	1	0
Prone (Ergometer)	7	0	0
Supine	2	1	5
Prone	8	0	0
Head-Down	8	0	0
Upright	8	0	0

Table 3
NCSC Switchover FFM Offgassing

Position	Diver Assessment		
	None	Slight	Excessive
Vertical (Ergometer)	13	0	0
Prone (Ergometer)	12	0	0
Supine	6	3	4
Prone	12	1	0
Head-Down	13	0	0
Upright	13	0	0

Table 4
AGA OC1 FFM Offgassing

Position	Diver Assessment		
	None	Slight	Excessive
Vertical (Ergometer)	6	1	0
Prone (Ergometer)	7	0	0
Supine	2	1	5
Prone	8	0	0
Head-Down	8	0	0
Upright	8	0	0

B. COMFORT EVALUATION (MINI-SAT 89)

Table 5
British FFM Comfort

Position	Diver Assessment: Comfortable	Slightly Uncomfortable	Very Uncomfortable
Vertical (Ergometer)	14	1	0
Prone (Ergometer)	13	2	0
Supine	10	5	0
Prone	15	0	0
Head-Down	13	2	0
Upright	13	0	0

Table 6
AGA Closed-Circuit FFM Comfort

Position	Diver Assessment: Comfortable	Slightly Uncomfortable	Very Uncomfortable
Vertical (Ergometer)	6	0	1
Prone (Ergometer)	4	3	0
Supine	2	4	2
Prone	1	5	2
Head-Down	2	5	1
Upright	7	1	0

Table 7
NCSC Switchover FFM Comfort

Position	Diver Assessment		
	Comfortable	Slightly Uncomfortable	Very Uncomfortable
Vertical (Ergometer)	10	2	0
Prone (Ergometer)	6	5	1
Supine	3	7	2
Prone	4	6	3
Head-Down	8	1	4
Upright	10	3	0

Table 8
AGA OCl FFM Comfort

Position	Diver Assessment		
	Comfortable	Slightly Uncomfortable	Very Uncomfortable
Vertical (Ergometer)	6	0	1
Prone (Ergometer)	4	3	0
Supine	2	4	2
Prone	1	5	2
Head-Down	2	5	1
Upright	7	1	0

C. SWITCHOVER MECHANISMS

1. The two mechanisms were judged by the divers as to overall ease of use in performing the umbilical connection and stitchover task.

Table 9
AGA OC1 FFM

Score Given	Divers Scoring at This Level
No Problem	3
Slightly Hard	3
Very Difficult	1

NOTE: While not depicted above, on two occasions the standby diver assisted the diver in finding the two switchover levers.

Table 10
NCSC Switchover FFM

Score Given	Divers Scoring at This Level
No Problem	10
Slightly Hard	1
Very Difficult	0

2. When asked, all divers reported a strong preference to the NCSC mechanism, citing location, number of maneuvers required and overall ease of use over the AGA OC1 mechanism.

D. OVERALL MASK PERFORMANCE

As stated earlier, the second phase of this study was to directly compare the British mask, preferred by most divers during Mini-Sat 89, and the Cressi-Sub FFM, preferred during tests of open circuit SCUBA FFM's. The results of this comparison were as follows. The numbers inside the graphs are the total number of divers scoring the mask at that level.

Table 11
Overall Mask Performance

Grade	Cressi-Sub FFM	British FFM
1	0	0
2	0	0
3	0	1
4	1	3
5	3	0
6	0	0

1 = Extremely Poor
2 = Poor
3 = Not Quite Adequate
4 = Adequate
5 = Very Good
6 = Excellent

All divers were asked to pick the mask they would prefer to dive in a cold water 2-hour dive scenario. Seventy-five percent of the divers stated they preferred the Cressi-Sub mask, one diver was indifferent and stated both masks were adequate.

VI. DISCUSSION

A. EQUIPMENT

1. The British FFM uses a spring clip to block the nostrils for equalization of the eustachian tubes and middle ear. Several divers reported trouble clearing caused by the nose clip not completely closing his nasal passages during forceful valsalva maneuvers. Discussion with British divers revealed that placing a second spring on the nose clip, while less comfortable, is their technique for eliminating this problem.

2. For this study, the AGA FFM, AGA OC1 and NCSC mask were dove using a low volume visor vice the standard visor to assess diver human factors performance. In the prone (swimming) position, the AGA FFM, AGA OC1 and NCSC

mask pushed up into several divers faces causing discomfort. This is caused by the hydrostatic load difference from the canister assembly being 10 to 12 inches above the face mask cavity. The opposite is true when a diver turns on his back (supine position). The mask cavity being above the canister causes an overpressurization in the mask with subsequent offgassing. The British and Cressi-Sub FFMs do not experience this phenomenon because the integral mouthpiece isolates the mask cavity from the breathing loop. Although beneficial for this reason, the use of the mouthpiece precludes diver to surface voice communication with these masks.

3. The Cressi-Sub mask, when used with a MK 16 mouthpiece, caused a pinching sensation on the upper lip. This problem was easily corrected to an acceptable comfort level by trimming the upper portion of the mouthpiece to eliminate squeezing the upper lip between the mouthpiece and mask.

4. Two types of rubber face seals were used on both the AGA and NCSC masks during this study. The tan colored silicone rubber mask manufactured by Interspiro (Sweden) and procured from Biomarine Inc. proved to be superior for facial sealing over the gray natural rubber mask provided by Interspiro.

5. For the purpose of this study, the MK 16 primary display was held in place with tape. NAVEODTECHCEN (Code 45) currently is developing a universal display mount which will work with multiple mask designs.

6. This dive series provided the first look at the concept of replacing the Conshelf second stage regulator currently on the emergency breathing system (EBS) with a connector that would allow the diver to simply plug the EBS umbilical into an open/closed circuit switchover FFM being worn. This configuration would eliminate the potentially hazardous situations identified during the MK 1 MOD 0 dry suit studies and MK 16 bounce dive series at NEDU. Those studies concluded that there is severe mouth and jaw fatigue when using an exposed mouthpiece in cold water in excess of 2 hours. The neoprene face shield used for thermal protection further complicates the situation since a diver cannot get a mouthpiece into his mouth without help when using the shield. Adoption of a FFM with switchover capability will eliminate these problem areas as well as provide for two way diver to surface communication. Discussions with NCSC Code (5110), who is tasked with development of the Type II EBS, confirmed that adapting this concept to their system can be easily accomplished once a mask is identified and approved for use.

7. Another area which was discussed at the MK 16 EBS planning meeting involving NCSC, NEDU, and NAVSEA 06X2 (May 1989) and warrants further exploration is supplying a diver with enhanced gas through the EBS. This gas, with a PO_2 as high as 1.3, the safe upper limit for indefinite exposure times[4] would significantly reduce a diver decompression obligation by as much as 35-45%[5], which in turn reduces the requirements for thermal protection.

VII. CONCLUSIONS

Due to the configuration and location of the MK 16 canister, a FFM which uses a mouthpiece to isolate the breathing loop from the mask cavity appears to be the only readily available option with regards to diver comfort at this time.

Of all the masks dove in both studies, the Cressi-Sub FFM was rated as the most comfortable throughout all diver orientations and evolutions.

In the comparison of the two switchover mechanisms, all divers preferred the NCSC mechanism over the AGA OC1 FFM. Reasons cited include the number and location of components and switches, and ease of identifying critical switching components.

VIII. RECOMMENDATIONS

It is recommended that the Cressi-Sub FFM be approved for use with the MK 16 UBA as optional equipment for cold/contaminated water diving operations. This is a low cost, easily adaptable alternative which will provide greater operational flexibility for the EOD community as an interim solution until a switchover capable FFM is identified and approved for use.

It is also recommended that the EOD community provide input along with the special warfare community in pursuing development of the NCSC switchover mechanism for use with the MK 15, MK 16, and EX 19. The use of the low volume visor (when approved) or the standard AGA visor should be left to diver preference.

REFERENCES

1. NAVSEA Task 88-60, Evaluation of Modified AGA Low Volume Full Face Mask for Use with MK 16 Operational Support Equipment.

2. Presswood, C.G., Evaluation of a Modified AGA Full Face Mask with Open Circuit/Closed Circuit Switchover Capability, Navy Experimental Diving Unit Report 13-87, October 1987.

3. Stanley, F.J., British SCUBA Full Face Mask Evaluation for Use with SCUBA in Cold Water/Contaminated Water, Navy Experimental Diving Unit Report 3-89, March 1989.

4. Naval Medical Research Institute letter serial DMD/90277, Maximum Partial Pressure of Oxygen (PO_2) Levels for USN Closed Circuit Underwater Breathing Apparatus (UBA), 7 March 1989.

5. Navy Experimental Diving Unit letter serial 023/85, MK 16 UBA High PPO_2 Decompression Investigation, 11 February 1986.